Variability in Software Systems – Extracted Data and Supplementary Material from a Systematic Literature Review

Galster, Matthias; Weyns, Danny; Tofan, Dan; Michalik, Bartosz; Avgeriou, Paris

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Matthias Galster, Danny Weyns, Dan Tofan, Bartosz Michalik, Paris Avgeriou

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1 OVERVIEW

This document summarizes all raw data extracted in a systematic literature review on variability in software systems (Variability in Software Systems – A Systematic Literature Review, Matthias Galster, Danny Weyns, Dan Tofan, Bartosz Michalik, Paris Avgeriou). Furthermore, this document provides supplementary information, including a comparison of primary studies included in the review with primary studies found in related systematic reviews, data extracted for a subset of studies to evaluate dimensions of variability, an analysis of studies related to SOA, as well as search strings used for a partial targeted automated search to complement the manual search for primary studies.

1.1 Context

Variability (i.e., the ability of software systems or artifacts to be adjusted for use in different contexts) became a key aspect in many software systems. Despite the vast body of work on variability, no systematic study exists on the claims associated with variability and the evidence that exists for these claims.

1.2 Objective

We analyze existing research on variability in software systems. We investigate variability handling in major software engineering phases (e.g., requirements engineering, architecting).

1.3 Method

We performed a systematic literature review. A manual search covered 13 premium software engineering journals and 18 premium conferences, resulting in 15430 papers searched and 196 papers considered for data collection. To improve the reliability of the studies found in the manual search and to increase reproducibility, we complemented the manual search with a targeted automated search.

2 PRIMARY STUDIES INCLUDED IN THE REVIEW

ID	Authors	Year	Title	Venue
1	L. Andrade et al.	2001	Enforcing business policies through automated reconfiguration	ASE
2	V. De Antonellis et al.	2006	A layered architecture for flexible Web service invocation	SPE
3	L. Apvrille et al.	2004	Verifying Service Continuity in a Dynamic Reconfiguration Procedure: Application to a Satellite System	ASEJ
4	D. Ardagna et al.	2007	PAWS: A Framework for Executing Adaptive Web-Service Processes	IEEE SW
5	D. Ardagna, B. Pernici	2007	Adaptive Service Composition in Flexible Processes	TSE
6	M. Ardis et al.	2000	Software product lines: a case study	SPE
7	C. Atkinson et al.	2000	Component-based product line development: the KobrA approach	SPLC
8	M. Ali Babar et al.	2010	Managing Variability in Software Product Lines	IEEE SW
9	L. Baresi et al.	2006	Style-based modeling and refinement of service-oriented architectures	SoSyM
10	I. Barone et al.	2008	COMOVER: Concurrent model versioning	ICSM
11	D. Batory et al.	2002	Achieving extensibility through product-lines and domain-specific languages: a case study	TOSEM
12	D. Batory et al.	2002	Generating product-lines of product-families	ASE
13	I. Bayley, H. Zhu	2010	Formal specification of the variants and behavioural features of design patterns	JSS
14	P. Bellavista et al.	2003	Context-aware middleware for resource management in the wireless Internet	TSE
15	S. Mokhtar et al.	2007	COCOA: COnversation-based service COmposition in pervAsive computing environments with QoS support	JSS
16	H. Benestad et al.	2009	Understanding software maintenance and evolution by analyzing individual changes: a literature review	SMRP
17	P. Bengtsson et al.	2004	Architecture-level modifiability analysis (ALMA)	JSS
18	I. Ben-Shaul et al.	2001	Dynamic adaptation and deployment of distributed components in Hadas	TSE
19	D. Beuche et al.	2007	Using Requirements Management Tools in Software Product Line Engineering: The State of the Practice	SPLC
20	D. Beuche et al.	2004	Variability management with feature models	SCP
21	P. Boinot et al.	2000	A declarative approach for designing and developing adaptive components	ASE
22	J. Bosch	2004	On the Development of Software Product-Family Components	SPLC
23	A. Braganca, R. Machado	2006	Extending UML 2.0 metamodel for complementary usages of the /spl Lt/extend/spl Gt/ relationship within use case variability specification	SPLC

ID	Authors	Year	Title	Venue
24	K. Breitman et al.	2005	Supporting scenario evolution	REJ
25	P. Brito et al.	2009	Verifying architectural variabilities in software fault tolerance techniques	ECSA
26	A. Brogi et al.	2006	On the semantics of software adaptation	SCP
27	A. Brogi et al.	2006	Component adaptation through flexible subservicing	SCP
28	S. Buhne et al.	2005	Modelling requirements variability across product lines	RE
29	G. Canfora et al.	2008	A framework for QoS-aware binding and re-binding of composite web services	JSS
30	J. Cao et al.	2003	Dynamic configuration management in a graph-oriented Distributed Programming Environment	SCP
31	J. Cao et al.	2006	An interactive service customization model	IST
32	M. Caporuscio et al.	2007	Model-based system reconfiguration for dynamic performance management	JSS
33	L. Capra et al.	2003	CARISMA: context-aware reflective middleware system for mobile applications	TSE
34	V. Cardellini et al.	2009	Qos-driven runtime adaptation of service oriented architectures	FSE
35	H. Cervantes, R. Hall	2004	Autonomous adaptation to dynamic availability using a service-oriented component model	ICSE
36	C. Cetina et al.	2009	Strategies for variability transformation at run-time	SPLC
37	T. Chaari et al.	2007	A comprehensive approach to model and use context for adapting applications in pervasive environments	JSS
38	A. Chan, C. Siu-Nam	2003	MobiPADS: a reflective middleware for context-aware mobile computing	TSE
39	S. Chang, S. Kim	2007	A Variability Modeling Method for Adaptable Services in Service-Oriented Computing	SPLC
40	L. Chen et al.	2009	Variability management in software product lines: a systematic review	SPLC
41	M. Chu-Carroll et al.	2002	Supporting aggregation in fine grained software configuration management	FSE
42	F. Cicirelli et al.	2010	A service-based architecture for dynamically reconfigurable workflows	JSS
43	M. Coriat et al.	2000	The SPLIT method: building product lines for software-intensive systems	SPLC
44	C. Costa et al.	2007	Dynamic Reconfiguration of Software Architectures Through Aspects	ECSA
45	C. Courbis, A. Finkelstein	2005	Towards aspect weaving applications	ICSE
46	S. Deelstra et al.	2009	Variability assessment in software product families	IST
47	G. Denaro et al.	2009	Ensuring interoperable service-oriented systems through engineered self-healing	FSE
48	D. Dhungana et al.	2008	Supporting the Evolution of Product Line Architectures with Variability Model Fragments	WICSA
49	G. Modica et al.	2009	Dynamic SLAs management in service oriented environments	JSS
50	E. Nitto et al.	2008	A journey to highly dynamic, self-adaptive service-based applications	ASEJ

ID	Authors	Year	Title	Venue
51	F. Dordowsky, W. Hipp	2009	Adopting software product line principles to manage software variants in a complex avionics system	SPLC
52	N. Duzbayev, I. Poernomo	2007	Pre-emptive Adaptation Through Classical Control Theory	QoSA
53	Y. Eracar, M. Kokar	2000	An architecture for software that adapts to changes in requirements	JSS
54	J. Floch et al.	2006	Using architecture models for runtime adaptability	IEEE SW
55	M. Forte et al.	2008	Using ontologies and Web services for content adaptation in Ubiquitous Computing	JSS
56	C. Fritsch, B. Renz	2004	Four Mechanisms for Adaptable Systems	SPLC
57	K. Fung, G. Low	2009	Methodology evaluation framework for dynamic evolution in composition-based distributed applications	JSS
58	C. Ghezzi et al.	2010	QoS Driven Dynamic Binding in-the-many	QoSA
59	I. Gorton et al.	2008	An extensible and lightweight architecture for adaptive server applications	SCP
60	A. Gruler et al.	2007	Development and Configuration of Service-based Product Lines	SPLC
61	J. van Gurp et al.	2010	Comparing practices for reuse in integration-oriented software product lines and large open source software projects	SPE
62	S. Hallsteinsen et al.	2006	Using product line techniques to build adaptive systems	SPLC
63	A. Harhurin, J. Hartmann	2008	Service-Oriented Commonality Analysis Across Existing Systems	SPLC
64	R. Hirschfeld, K. Kawamura	2006	Dynamic service adaptation	SPE
65	A. van der Hoek et al.	2001	Taming architectural evolution	FSE
66	M. Karam et al.	2008	A product-line architecture for web service-based visual composition of web applications	JSS
67	M. Koning et al.	2009	VxBPEL: Supporting variability for Web services in BPEL	IST
68	J. Lee, K. Kang	2006	A feature-oriented approach to developing dynamically reconfigurable products in product line engineering	SPLC
69	J. Lee, G. Kotonya	2010	Combining Service-Orientation with Product Line Engineering	IEEE SW
70	J. Lee et al.	2008	An Approach for Developing Service Oriented Product Lines	SPLC
71	E. Niemelä, A. Immonen	2007	Capturing quality requirements of product family architecture	IST
72	C. Parra et al.	2009	Context awareness for dynamic service-oriented product lines	SPLC
73	S. Previtali, T. Gross	2006	Dynamic Updating of Software Systems Based on Aspects	ICSM
74	R. Schantz et al.	2006	Controlling quality-of-service in distributed real-time and embedded systems via adaptive middleware	SPE
75	M. Sinnema, S. Deelstra	2007	Classifying variability modeling techniques	IST
76	M. Sinnema et al.	2004	COVAMOF: A Framework for Modeling Variability in Software Product Families	SPLC

ID	Authors	Year	Title	Venue
77	C. Sun et al.	2010	Modeling and managing the variability of Web service-based systems	JSS
78	H. Sun et al.	2009	Product-line-based requirements customization for web service compositions	SPLC
79	M. Svahnberg et al.	2005	A taxonomy of variability realization techniques	SPE
80	S. Thiel, A. Hein	2002	Systematic Integration of Variability into Product Line Architecture Design	SPLC
81	E. Truyen et al.	2001	Dynamic and selective combination of extensions in component-based applications	ICSE
82	J. van Gurp, J. Savolainen	2006	Service grid variability realization	SPLC
83	Y. Wang, J. Mylopoulos	2009	Self-Repair through Reconfiguration: A Requirements Engineering Approach	ASE
84	I. Warren et al.	2006	An Automated Formal Approach to Managing Dynamic Reconfiguration	ASE
85	E. Wohlstadter et al.	2004	GlueQoS: middleware to sweeten quality-of-service policy interactions	ICSE
86	S. Yau et al.	2008	Specification, decomposition and agent synthesis for situation-aware service-based systems	JSS
87	H. Zhang, S. Jarzabek	2004	XVCL: a mechanism for handling variants in software product lines	SCP
88	A. Zisman et al.	2008	A Framework for Dynamic Service Discovery	ASE
89	N. Aguirre, T. Maibaum	2002	A temporal logic approach to the specification of reconfigurable component-based systems	ASE
90	S. Ajila, Ali Kaba	2008	Evolution support mechanisms for software product line process	JSS
91	V. Alagar et al.	2003	A rigorous approach for constructing self-evolving real-time reactive systems	IST
92	P. America et al.	2004	Scenario-Based Decision Making for Architectural Variability in Product Families	SPLC
93	T. Asikainen et al.	2006	A unified conceptual foundation for feature modelling	SPLC
94	P. Bachara et al.	2010	Framework for application management with dynamic aspects J-EARS case study	IST
95	L. Baresi et al.	2004	Style-based refinement of dynamic software architectures	WICSA
96	M. Bernardo et al.	2002	Architecting families of software systems with process algebras	TOSEM
97	J. Bosch	2002	Maturity and Evolution in Software Product Lines: Approaches, Artefacts and Organi-zation	SPLC
98	G. Botterweck et al.	2008	Visual Tool Support for Configuring and Understanding Software Product Lines	SPLC
99	A. Braganca, R. Machado	2007	Automating Mappings between Use Case Diagrams and Feature Models for Software Product Lines	SPLC
100	T. Brown et al.	2002	Adaptable Components for Software Product Line Engineering	SPLC
101	A. Bucchiarone et al.	2009	Self-Repairing systems modeling and verification using AGG	WICSA
102	P. Buhr, W. Mok	2000	Advanced exception handling mechanisms	TSE
103	R. Capilla, M. Ali Babar	2008	On the Role of Architectural Design Decisions in Software Product Line Engineering	ECSA

ID	Authors	Year	Title	Venue
104	C. Cetina et al.	2008	Applying Software Product Lines to Build Autonomic Pervasive Systems	SPLC
105	F. Chauvel et al.	2010	Using QoS-Contracts to Drive Architecture-Centric Self-adaptation	QoSA
106	H. Chu et al.	2004	Roam, a seamless application framework	JSS
107	L. Chung, N. Subramanian	2003	Architecture-based semantic evolution of embedded remotely controlled systems	SMRP
108	J. Cobleigh et al.	2002	Containment units: a hierarchically composable architecture for adaptive systems	FSE
109	A. Colman, J. Han	2007	Using role-based coordination to achieve software adaptability	SCP
110	C. Costa-Soria et al.	2008	Managing Dynamic Evolution of Architectural Types	ECSA
111	E. Curry, P. Grace	2008	Flexible Self-Management Using the Model-View-Controller Pattern	IEEE SW
112	K. Czarnecki et al.	2008	Sample Spaces and Feature Models: There and Back Again	SPLC
113	S. Deelstra et al.	2005	Product derivation in software product families: a case study	JSS
114	J. Dehlinger, R. Lutz	2006	PLFaultCAT: A Product-Line Software Fault Tree Analysis Tool	ASEJ
115	J. Dehlinger, R. Lutz	2008	Supporting requirements reuse in multi-agent system product line design and evolution	ICSM
116	C. Rosso	2008	Software performance tuning of software product family architectures: Two case studies in the real-time embedded systems domain	JSS
117	D. Dhungana et al.	2010	Structuring the modeling space and supporting evolution in software product line engineering	JSS
118	M. Eriksson et al.	2009	Managing requirements specifications for product lines - An approach and industry case study	JSS
119	J. Estublier, G. Vega	2005	Reuse and variability in large software applications	FSE
120	L. Etxeberria, G. Sagardui	2008	Variability Driven Quality Evaluation in Software Product Lines	SPLC
121	A. Fantechi, S. Gnesi	2008	Formal Modeling for Product Families Engineering	SPLC
122	S. Faulk	2001	Product-line requirements specification (PRS): an approach and case study	RE
123	Q. Feng, R. Lutz	2005	Bi-directional safety analysis of product lines	JSS
124	E. Figueiredo et al.	2008	Evolving software product lines with aspects	ICSE
125	A. Fortier et al.	2010	Dealing with variability in context-aware mobile software	JSS
126	G. Gannod, R. Lutz	2000	An approach to architectural analysis of product lines	ICSE
127	A. Garg et al.	2003	An environment for managing evolving product line architectures	ICSM
128	K. Geihs et al.	2009	A comprehensive solution for application-level adaptation	SPE
129	M. Goedicke et al.	2004	Designing runtime variation points in product line architectures: three cases	SCP
130	H. Gomaa, M. Hussein	2004	Software reconfiguration patterns for dynamic evolution of software architectures	WICSA

ID	Authors	Year	Title	Venue
131	B. Gonzales-Baixauli, et al.	2004	Visual variability analysis for goal models	RE
132	A. Gregersen, B. Jørgensen	2009	Dynamic update of Java applications - balancing change flexibility vs programming transparency	SMRP
133	R. Gumzej et al.	2009	A reconfiguration pattern for distributed embedded systems	SoSyM
134	A. Hallerbach et al.	2010	Capturing variability in business process models: the Provop approach	SMRP
135	G. Halmans, K. Pohl	2003	Communicating the variability of a software-product family to customers	JSS
136	M. Abu-Matar, H. Gomaa	2011	Variability Modeling for Service Oriented Product Line Architectures	SPLC
137	R. Ali et al.	2010	A goal-based framework for contextual requirements modeling and analysis	REJ
138	A. C. Contieri et al.	2011	Extending UML components to develop software product-line architectures: lessons learned	ECSA
139	P. Asirelli et al.	2011	Formal Description of Variability in Product Families	SPLC
140	R. Baird et al.	2011	Self-adapting workflow reconfiguration	JSS
141	J. Ferreira Bastos et al.	2011	Adopting software product lines: a systematic mapping study	EASE
142	T. Berger et al.	2010	Variability modeling in the real: a perspective from the operating systems domain	ASE
143	R. Cavalcanti et al.	2011	Extending the RiPLE-DE process with quality attribute variability realization	QoSA
144	L. Chen, M. Ali Babar	2011	A systematic review of evaluation of variability management approaches in software product lines	IST
145	K. Czarnecki, M. Antkiewicz	2005	Mapping Features to Models: A Template Approach Based on Superimposed Variants	GPCE
146	D. Dhungana et al.	2011	The DOPLER meta-tool for decision-oriented variability modeling: a multiple case study	ASEJ
147	M. Erwig	2010	A language for software variation research	GPCE
148	M. Erwig, E. Walkingshaw	2011	The Choice Calculus: A Representation for Software Variation	TOSEM
149	N. Esfahani, S. Malek	2010	On the role of architectural styles in improving the adaptation support of middleware platforms	ECSA
150	J. Feigenspan et al.	2011	Using background colors to support program comprehension in software product lines	EASE
151	M. Galster, P. Avgeriou	2011	Handling Variability in Software Architecture: Problems and Implications	WICSA
152	N. Gui et al.	2011	Toward architecture-based context-aware deployment and adaptation	JSS
153	A. Haber et al.	2011	Hierarchical Variability Modeling for Software Architectures	SPLC
154	A. Heuer et al.	2010	Formal Definition of Syntax and Semantics for Documenting Variability in Activity Dia-grams	SPLC
155	C. Kaestner et al.	2011	Variability-aware parsing in the presence of lexical macros and conditional compilation	OOPSLA

ID	Authors	Year	Title	Venue
156	S. Kato, N. Yamaguchi	2011	Variation Management for Software Product Lines with Cumulative Coverage of Feature Interactions	SPLC
157	J. Liebig, et al.	2010	An analysis of the variability in forty preprocessor-based software product lines	ICSE
158	X. Peng et al.	2011	Analyzing evolution of variability in a software product line: From contexts and requirements to features	IST
159	M. Rosenmueller et al.	2011	Tailoring dynamic software product lines	GPCE
160	M. Rosenmueller et al.	2011	Flexible feature binding in software product lines	ASEJ
161	U. Ryssel	2010	Automatic variation-point identification in function-block-based models	GPCE
162	K. Schmid	2010	Variability Modeling for Distributed Development – A Comparison with Established Practice	SPLC
163	J. Sincero et al.	2010	Efficient extraction and analysis of preprocessor-based variability	GPCE
164	C. Thörn	2010	Current state and potential of variability management practices in software-intensive SMEs: Results from a regional industrial survey	IST
165	M. Vierhauser et al.	2010	Flexible and scalable consistency checking on product line variability models	ASE
166	D. Weyns et al.	2011	An Architectural Approach to Support Online Updates of Software Product Lines	WICSA
167	M. Acher et al.	2010	Composing Feature Models	SLE
168	M. Alferez et al.	2010	Multi-view Composition Language for Software Product Line Requirements	SLE
169	V. Andrikopoulos et al.	2008	Managing the Evolution of Service Specifications	CAiSE
170	D. Benavides et al.	2005	Automated Reasoning on Feature Models	CAiSE
171	J. Bergh, K. Coninx	2006	CUP 2.0: High-Level Modeling of Context-Sensitive Interactive Applications	MODELS
172	K. Boukadi et al.	2008	An Aspect Oriented Approach for Context-Aware Service Domain Adapted to E-Business	CAiSE
173	F. Casati et al.	2000	Adaptive and Dynamic Service Composition in eFlow	CAiSE
174	M. Cengarle et al.	2009	Variability within Modeling Language Definitions	MODELS
175	F. Dalpiaz et al.	2009	An Architecture for Requirements-Driven Self-reconfiguration	CAiSE
176	C. Dorn, S. Dustdar	2010	Interaction-Driven Self-adaptation of Service Ensembles	CAiSE
177	F. Fleurey, A. Solberg	2009	A Domain Specific Modeling Language Supporting Specification, Simulation and Execution of Dynamic Adaptive Systems	MODELS
178	G. Halmans et al.	2008	Documenting Application-Specific Adaptations in Software Product Line Engineering	CAiSE
179	P. Jayaraman et al.	2007	Model Composition in Product Lines and Feature Interaction Detection Using Critical Pair Analysis	MODELS
180	P. Lahire et al.	2007	Introducing Variability into Aspect-Oriented Modeling Approaches	MODELS

ID	Authors	Year	Title	Venue
181	B. Morin et al.	2009	Weaving Variability into Domain Metamodels	MODELS
182	A. Reuys et al.	2005	Model-Based System Testing of Software Product Families	CAiSE
183	S. Shiraishi	2010	An AADL-Based Approach to Variability Modeling of Automotive Control Systems	MODELS
184	A. Shui et al.	2005	Exceptional Use Cases	MODELS
185	B. Weber et al.	2007	Change Patterns and Change Support Features in Process-Aware Information Systems	CAiSE
186	S. Zschaler et al.	2010	VML* – A Family of Languages for Variability Management in Software Product Lines	SLE
187	K. Bak et al.	2011	Feature and Meta-Models in Clafer: Mixed, Specialized, and Coupled	SLE
188	S. Liaskos et al.	2011	Goal-Based Behavioral Customization of Information Systems	CAiSE
189	B. Pernici, S. Siadat	2011	A Fuzzy Service Adaptation Based on QoS Satisfaction	CAiSE
190	N. Qureshi et al.	2011	Requirements Engineering for Self-Adaptive Systems: Core Ontology and Problem Statement	CAiSE
191	M. Weidlich et al.	2011	A Foundational Approach for Managing Process Variability	CAiSE
192	M. Mezini, K. Ostermann	2004	Variability Management with Feature-oriented Programming and Aspects	FSE
193	D. Webber, H. Gomaa	2004	Modeling Variability in Software Product Lines with the Variation Point Model	SCP
194	A. Classen et al.	2010	Model Checking lots of Systems: Efficient Verification of Temporal Properties in Software Product Lines	ICSE
195	A. Classen et al.	2011	A Text-based Approach to Feature Modelling: Syntax and Semantics of TVL	SCP
196	S. Kim et al.	2005	A Theoretical Foundation of Variability in Component-based Development	IST

3 COMPARISON OF PRIMARY STUDIES WITH PRIMARY STUDIES INCLUDED IN RELATED REVIEWS

Study	In Chen and Babar ("A systematic review of evaluation of variability management approaches in software product lines")	In Chen et al. ("Variability management in software product lines: a systematic review")	In A. Kontogogos, P. Avgeriou, "Towards modeling variability-intensive SOA systems"	In R. Kazhamiakin et al, "Adaptation of service-based systems"	In V. Alves et al., "Requirements engineering for software product lines: a systematic review"
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Study	In Chen and Babar (“A systematic review of evaluation of variability management approaches in software product lines”)	In Chen et al. ("Variability management in software product lines: a systematic review")	In A. Kontogogos, P. Avgeriou, “Towards modeling variability-intensive SOA systems”	In R. Kazhamiakin et al, “Adaptation of service-based systems”	In V. Alves et al., “Requirements engineering for software product lines: a systematic review”
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Study	In Chen and Babar (“A systematic review of evaluation of variability management approaches in software product lines”)	In Chen et al. ("Variability management in software product lines: a systematic review")	In A. Kontogogos, P. Avgeriou, “Towards modeling variability-intensive SOA systems”	In R. Kazhamiakin et al, “Adaptation of service-based systems”	In V. Alves et al., “Requirements engineering for software product lines: a systematic review”
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Study	In Chen and Babar (“A systematic review of evaluation of variability management approaches in software product lines”)	In Chen et al. ("Variability management in software product lines: a systematic review")	In A. Kontogogos, P. Avgeriou, “Towards modeling variability-intensive SOA systems”	In R. Kazhamiakin et al, “Adaptation of service-based systems”	In V. Alves et al., “Requirements engineering for software product lines: a systematic review”
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Study	In Chen and Babar (“A systematic review of evaluation of variability management approaches in software product lines”)	In Chen et al. ("Variability management in software product lines: a systematic review")	In A. Kontogogos, P. Avgeriou, “Towards modeling variability-intensive SOA systems”	In R. Kazhamiakin et al, “Adaptation of service-based systems”	In V. Alves et al., “Requirements engineering for software product lines: a systematic review”
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Study	In Chen and Babar (“A systematic review of evaluation of variability management approaches in software product lines”)	In Chen et al. ("Variability management in software product lines: a systematic review")	In A. Kontogogos, P. Avgeriou, “Towards modeling variability-intensive SOA systems”	In R. Kazhamiakin et al, “Adaptation of service-based systems”	In V. Alves et al., “Requirements engineering for software product lines: a systematic review”
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Study	In Chen and Babar (“A systematic review of evaluation of variability management approaches in software product lines”)	In Chen et al. ("Variability management in software product lines: a systematic review")	In A. Kontogogos, P. Avgeriou, “Towards modeling variability-intensive SOA systems”	In R. Kazhamiakin et al, “Adaptation of service-based systems”	In V. Alves et al., “Requirements engineering for software product lines: a systematic review”
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192					
193	x	x			

Study	In Chen and Babar (“A systematic review of evaluation of variability management approaches in software product lines”)	In Chen et al. ("Variability management in software product lines: a systematic review")	In A. Kontogogos, P. Avgeriou, “Towards modeling variability-intensive SOA systems”	In R. Kazhamiakin et al, “Adaptation of service-based systems”	In V. Alves et al., “Requirements engineering for software product lines: a systematic review”
194					
195					
196					

4 DATA EXTRACTED FROM PRIMARY STUDIES

4.1 Variability types

(RT = runtime variability, DT = design time variability)

Study	Variability type
1	RT
2	RT
3	RT
4	RT
5	RT
6	DT
7	n/a
8	n/a
9	RT
10	DT
11	DT
12	DT
13	DT
14	DT
15	RT
16	n/a
17	DT
18	DT
19	n/a
20	n/a
21	RT
22	n/a
23	n/a
24	DT
25	DT
26	n/a
27	DT
28	DT
29	RT
30	DT
31	DT
32	RT
33	RT
34	DT
35	RT

Study	Variability type
36	RT
37	RT
38	RT
39	DT
40	n/a
41	DT
42	RT
43	DT
44	DT
45	DT
46	n/a
47	RT
48	DT
49	DT
50	DT
51	DT
52	DT
53	n/a
54	RT
55	RT
56	DT
57	RT
58	RT
59	RT
60	DT
61	DT
62	DT
63	DT
64	RT
65	DT
66	RT
67	RT
68	DT
69	DT
70	RT
71	RT
72	RT
73	DT
74	RT
75	n/a
76	DT
77	RT

Study	Variability type
78	RT
79	DT
80	DT
81	DT
82	RT
83	DT
84	DT
85	RT
86	RT
87	DT
88	RT
89	n/a
90	DT
91	DT
92	DT
93	DT
94	n/a
95	RT
96	n/a
97	DT
98	DT
99	DT
100	DT
101	RT
102	DT
103	DT
104	DT
105	RT
106	RT
107	DT
108	RT
109	DT
110	RT
111	RT
112	DT
113	DT
114	DT
115	DT
116	DT
117	DT
118	DT
119	DT

Study	Variability type
120	DT
121	DT
122	DT
123	DT
124	DT
125	DT
126	DT
127	DT
128	DT
129	DT
130	DT
131	DT
132	DT
133	DT
134	RT
135	DT
136	DT
137	DT
138	DT
139	DT
140	DT
141	DT
142	DT
143	DT
144	n/a
145	DT
146	DT
147	DT
148	DT
149	DT
150	DT
151	DT
152	DT
153	DT
154	DT
155	DT
156	DT
157	DT
158	DT
159	DT
160	DT
161	DT

Study	Variability type
162	DT
163	n/a
164	n/a
165	DT
166	DT
167	DT
168	DT
169	DT
170	DT
171	DT
172	RT
173	RT
174	RT
175	DT
176	DT
177	DT
178	DT
179	DT
180	DT
181	DT
182	DT
183	DT
184	DT
185	RT
186	DT
187	DT
188	RT
189	RT
190	RT
191	DT
192	DT
193	DT
194	DT
195	DT
196	DT

4.2 Addressed activities

(1 = addressed, 0 = not addressed)

Study	Requirements	Architecture	Design	Implementation	Testing	Maintenance
1	0	0	1	0	0	0
2	0	1	0	0	0	0
3	0	0	0	1	1	1
4	0	1	0	0	0	0
5	0	0	1	0	0	0
6	1	0	1	0	1	0
7	1	0	1	0	0	0
8	0	0	0	0	0	0
9	0	0	1	0	0	0
10	0	0	0	1	0	1
11	0	0	1	0	0	0
12	0	0	1	1	0	1
13	0	0	1	0	0	0
14	0	1	0	0	0	0
15	0	0	1	0	0	0
16	0	0	0	1	0	1
17	0	0	1	1	0	1
18	0	0	1	0	0	0
19	1	0	0	0	0	0
20	0	0	1	0	0	0
21	0	0	1	0	0	0
22	0	0	1	0	0	0
23	0	0	0	0	0	0
24	1	0	1	0	0	0
25	0	0	1	0	0	0
26	0	0	0	1	0	1
27	0	0	1	0	0	0
28	1	0	0	0	0	0
29	0	0	1	0	0	0
30	0	0	1	0	0	0
31	0	0	0	0	0	0
32	0	1	0	0	0	0
33	0	0	1	0	0	0
34	0	1	0	0	0	0
35	0	0	0	0	0	0
36	0	0	0	1	0	0
37	0	1	0	0	0	0
38	0	1	0	0	0	0

Study	Requirements	Architecture	Design	Implementation	Testing	Maintenance
39	0	1	1	0	0	0
40	0	0	0	0	0	0
41	0	0	0	1	0	1
42	0	0	1	0	0	0
43	1	0	1	0	0	0
44	0	1	0	0	0	0
45	0	0	1	0	0	0
46	1	0	1	1	0	1
47	0	0	1	0	0	0
48	0	0	0	0	0	0
49	0	0	1	0	0	0
50	0	0	0	0	0	0
51	1	1	0	1	1	1
52	0	1	0	0	0	0
53	0	0	0	0	0	0
54	0	0	1	0	0	0
55	0	1	0	0	0	0
56	0	0	1	0	0	0
57	0	1	0	0	0	0
58	0	0	0	0	0	0
59	0	1	1	0	0	0
60	0	0	1	0	0	0
61	0	1	1	0	0	0
62	0	1	1	0	0	0
63	0	1	0	0	0	0
64	0	0	1	0	0	0
65	0	1	1	1	0	1
66	0	1	0	0	0	0
67	0	1	0	0	0	0
68	0	1	0	0	0	0
69	0	1	0	0	0	0
70	0	1	0	0	0	0
71	0	1	0	0	0	0
72	0	1	0	0	0	0
73	0	0	0	1	0	1
74	0	1	0	0	0	0
75	0	0	0	0	0	0
76	1	1	1	0	0	0
77	0	1	0	0	0	0
78	0	1	0	0	0	0
79	0	1	0	1	0	1
80	1	1	1	0	0	0

Study	Requirements	Architecture	Design	Implementation	Testing	Maintenance
81	0	1	0	0	0	0
82	0	1	0	0	0	0
83	0	1	0	0	0	0
84	0	1	0	1	0	1
85	0	1	0	1	0	1
86	0	1	0	0	0	0
87	0	0	0	1	0	1
88	0	0	0	1	0	0
89	0	0	1	0	0	0
90	0	0	1	0	0	0
91	0	0	1	0	0	0
92	0	0	1	0	0	0
93	0	0	1	0	0	0
94	1	0	1	0	0	0
95	0	0	1	0	0	0
96	0	0	1	0	0	0
97	0	0	0	0	0	0
98	1	0	1	0	0	0
99	1	0	1	0	0	0
100	0	0	0	1	0	0
101	0	1	0	0	0	0
102	0	0	0	1	0	0
103	0	1	0	0	0	0
104	0	0	1	0	0	0
105	0	0	0	0	0	1
106	0	0	0	1	0	0
107	0	0	0	0	0	1
108	0	1	0	0	0	0
109	0	0	1	0	0	0
110	0	1	0	0	0	0
111	0	1	0	0	0	0
112	0	0	1	0	0	0
113	0	0	1	0	0	0
114	0	1	0	0	0	0
115	0	1	0	0	0	0
116	0	0	1	0	0	0
117	0	0	1	0	0	0
118	0	0	1	0	0	0
119	0	0	1	0	0	0
120	1	0	0	0	0	0
121	1	0	0	0	0	0
122	1	0	1	0	0	0

Study	Requirements	Architecture	Design	Implementation	Testing	Maintenance
123	1	0	0	0	0	0
124	0	0	0	1	0	0
125	0	1	0	0	0	0
126	0	1	0	0	0	0
127	0	0	0	0	0	1
128	0	0	1	0	0	0
129	0	0	1	0	0	0
130	0	0	1	0	0	0
131	0	0	0	0	0	1
132	0	1	0	0	0	0
133	0	1	0	0	0	0
134	1	0	0	0	0	0
135	1	0	0	0	0	0
136	0	1	1	0	0	0
137	1	0	0	0	0	0
138	0	1	1	0	0	0
139	0	1	0	0	0	0
140	1	0	0	0	0	0
141	0	0	0	0	0	0
142	0	0	1	0	0	0
143	0	1	1	0	0	0
144	0	0	0	0	0	0
145	0	0	1	0	0	0
146	0	1	1	0	0	0
147	0	0	1	0	0	1
148	0	0	0	0	0	1
149	0	0	0	0	0	1
150	0	0	0	0	0	0
151	0	1	0	0	0	0
152	1	1	0	0	0	0
153	0	1	0	0	0	0
154	1	0	0	0	0	0
155	0	0	0	1	0	0
156	0	0	0	0	1	0
157	0	0	0	0	0	0
158	1	0	0	0	0	1
159	0	0	1	1	0	0
160	0	0	0	1	0	0
161	0	0	0	0	0	1
162	0	0	0	0	0	0
163	0	0	0	0	0	1
164	0	0	0	0	0	1

Study	Requirements	Architecture	Design	Implementation	Testing	Maintenance
165	0	0	1	0	0	0
166	0	0	0	0	0	1
167	0	1	1	0	0	0
168	1	0	0	0	0	0
169	0	1	1	0	0	0
170	0	1	1	0	0	0
171	0	1	1	0	0	0
172	0	1	1	0	0	0
173	0	1	1	0	0	0
174	0	1	1	0	0	0
175	1	1	0	0	0	0
176	1	0	0	0	0	0
177	0	0	1	0	0	0
178	0	0	1	0	0	0
179	0	0	1	0	0	0
180	0	0	1	0	0	0
181	0	0	1	0	0	0
182	0	0	0	0	1	0
183	0	1	0	0	0	0
184	1	0	0	0	0	0
185	1	0	0	0	0	0
186	0	0	1	0	0	0
187	0	1	1	0	0	0
188	1	0	0	0	0	0
189	0	1	1	0	0	0
190	1	0	0	0	0	0
191	0	1	1	0	0	0
192	0	0	1	1	0	0
193	1	1	1	0	0	0
194	0	1	0	0	0	0
195	0	1	0	0	0	0
196	0	1	0	0	0	0

4.3 Runtime quality attributes

(1 = addressed, 0 = not addressed)

Study	Availability	Autonomy	Evolvability	Flexibility	Interoperability	Performance	"QoS"	Reliability	Scalability	Security	Safety	Concurrency
1	0	0	0	1	0	0	0	0	0	0	0	0
2	1	0	0	0	0	1	0	0	0	0	0	0
3	0	0	0	0	0	0	1	0	0	0	0	0
4	1	0	0	1	0	1	0	0	0	0	0	0
5	1	0	0	0	0	1	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	1	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	1	0	1	0	1	0	0	0	0	0	0
15	1	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	1	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	1	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0

Study	Availability	Autonomy	Evolvability	Flexibility	Interoperability	Performance	"QoS"	Reliability	Scalability	Security	Safety	Concurrency
27	0	0	0	0	0	0	0	0	0	1	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	1	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	1	0	0	1	0	0	0	0	0
35	1	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	1	0	0	0	0	0	0
37	0	0	0	0	1	0	0	0	0	0	0	0
38	1	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	1	0	0	0	0	0	0
42	0	0	0	0	0	1	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	1	0	0	0	0	0	0	0	0	0
45	0	0	1	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	1	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	1	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	1	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	1	0	0	0	0	0	0
55	0	0	0	0	0	1	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0

Study	Availability	Autonomy	Evolvability	Flexibility	Interoperability	Performance	"QoS"	Reliability	Scalability	Security	Safety	Concurrency
57	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	1	1	0	0	0	0	0
59	0	0	0	0	0	1	0	0	0	0	0	0
60	0	0	1	1	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	1	1	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	1	0	0	0	0	0	0	0	0
67	1	0	0	1	0	1	0	0	0	0	0	0
68	1	0	0	1	0	0	0	0	0	0	0	0
69	1	0	0	1	0	0	0	0	0	0	0	0
70	1	0	0	1	0	0	0	0	1	0	0	0
71	1	0	0	0	1	0	0	1	0	0	0	0
72	0	0	1	1	0	0	0	0	0	0	0	0
73	1	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	1	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	1	1	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	1	0	0	0	0
79	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	1	0	0	0
82	0	0	0	0	0	1	0	0	0	0	0	0
83	0	0	0	0	0	1	0	0	1	0	0	0
84	1	0	0	0	0	0	0	0	0	0	0	0
85	1	0	0	1	0	0	0	0	0	0	0	0
86	0	0	1	1	0	0	0	0	0	0	0	0

Study	Availability	Autonomy	Evolvability	Flexibility	Interoperability	Performance	"QoS"	Reliability	Scalability	Security	Safety	Concurrency
87	0	0	0	0	0	0	0	0	0	0	0	0
88	1	0	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0
91	0	0	0	0	0	0	0	0	0	0	0	0
92	0	0	0	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0	0	0
94	0	0	0	0	0	0	0	0	0	0	0	0
95	1	0	0	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	1	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0	0	0
104	1	0	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	1	0	0	0	1	0	0
106	0	0	0	1	0	0	0	0	0	0	0	0
107	0	0	0	0	0	0	0	0	0	0	0	0
108	0	0	0	1	0	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	0	0	0	0	0
110	0	0	0	1	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0	0	0	0	0
112	0	0	0	0	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	1	0	0	0	0	0	0

Study	Availability	Autonomy	Evolvability	Flexibility	Interoperability	Performance	"QoS"	Reliability	Scalability	Security	Safety	Concurrency
117	0	0	0	0	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0	0	0	0	0
119	0	0	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0	0	0	0
122	0	0	0	0	0	0	0	0	0	0	0	0
123	0	0	0	0	0	0	0	0	0	0	1	0
124	0	0	0	0	0	0	0	0	0	0	0	0
125	0	0	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0	0	0	0
128	0	0	0	1	0	0	0	0	0	0	0	0
129	0	0	0	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0	0	0
132	0	0	0	1	0	1	0	0	0	0	0	1
133	0	0	0	0	0	0	0	0	0	0	0	0
134	0	0	0	0	0	0	0	0	0	0	0	0
135	0	0	0	0	0	0	0	0	0	0	0	0
136	0	0	0	0	0	0	0	0	0	0	0	0
137	0	0	0	0	0	0	0	0	0	0	0	0
138	0	0	0	0	0	0	0	0	0	0	0	0
139	0	0	0	0	0	0	0	0	0	0	0	0
140	0	0	0	1	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0	0	0
142	0	0	0	0	0	0	0	0	0	0	0	0
143	0	0	0	0	0	0	0	0	0	0	0	0
144	0	0	0	0	0	0	0	0	0	0	0	0
145	0	0	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0	0	0

Study	Availability	Autonomy	Evolvability	Flexibility	Interoperability	Performance	"QoS"	Reliability	Scalability	Security	Safety	Concurrency
147	0	0	0	0	0	0	0	0	0	0	0	0
148	0	0	0	0	0	0	0	0	0	0	0	0
149	0	0	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0	0	0
152	0	0	0	0	0	1	0	0	0	0	0	0
153	0	0	0	0	0	0	0	0	0	0	0	0
154	0	0	0	0	0	0	0	0	0	0	0	0
155	0	0	0	0	0	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0	0
157	0	0	0	0	0	0	0	0	0	0	0	0
158	0	0	0	0	0	0	0	0	0	0	0	0
159	0	0	0	0	0	0	0	0	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0	0	0
162	0	0	0	0	0	0	0	0	0	0	0	0
163	0	0	0	0	0	0	0	0	0	0	0	0
164	0	0	0	0	0	0	0	0	0	0	0	0
165	0	0	0	0	0	0	0	0	0	0	0	0
166	1	0	0	0	0	0	0	0	0	0	0	0
167	0	0	0	0	0	0	0	0	0	0	0	0
168	0	0	0	0	0	0	0	0	0	0	0	0
169	0	0	0	0	0	0	0	0	0	0	0	0
170	1	0	0	0	0	0	0	1	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0	0
172	0	0	0	0	0	0	1	0	0	0	0	0
173	0	0	0	0	0	0	0	0	0	0	0	0
174	0	0	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0	0

Study	Availability	Autonomy	Evolvability	Flexibility	Interoperability	Performance	"QoS"	Reliability	Scalability	Security	Safety	Concurrency
177	0	0	0	0	0	0	0	0	0	0	0	0
178	0	0	0	0	0	0	0	0	0	0	0	0
179	0	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0	0
182	0	0	0	0	0	0	0	0	0	0	0	0
183	0	0	0	0	0	0	0	0	0	0	0	0
184	0	0	0	0	0	0	0	0	0	0	0	0
185	0	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0	0
187	0	0	0	0	0	0	0	0	0	0	0	0
188	0	0	0	0	0	0	0	0	0	0	0	0
189	0	0	0	0	0	0	1	0	0	0	0	0
190	1	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0
192	0	0	0	0	0	0	0	0	0	0	0	0
193	0	0	0	0	0	0	0	0	0	0	0	0
194	0	0	0	0	0	0	0	0	0	0	0	0
195	0	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0	0

4.4 Design time quality attributes

(1 = addressed, 0 = not addressed)

Study	Flexibility	Reconfigurability	Expressiveness	Readability	Modifiability	Adaptability	Portability	Modularity	Reusability	Maintainability	Evolvability
1	0	0	0	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
9	0	1	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0
13	0	0	1	1	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	1	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0

Study	Flexibility	Reconfigurability	Expressiveness	Readability	Modifiability	Adaptability	Portability	Modularity	Reusability	Maintainability	Evolvability
27	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0
30	1	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0
32	1	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0
38	1	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0
41	1	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	1	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0
50	1	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	1	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	1	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0
56	1	0	0	0	0	0	0	0	0	0	0

Study	Flexibility	Reconfigurability	Expressiveness	Readability	Modifiability	Adaptability	Portability	Modularity	Reusability	Maintainability	Evolvability
57	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	1	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	1	0	0
62	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0
65	1	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	1	0	0
71	1	0	0	0	0	0	0	0	1	0	0
72	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0	1	0	0
79	0	0	0	0	0	0	0	0	0	0	0
80	1	0	0	0	1	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	0	0	0	0	0

Study	Flexibility	Reconfigurability	Expressiveness	Readability	Modifiability	Adaptability	Portability	Modularity	Reusability	Maintainability	Evolvability
87	0	0	0	0	0	0	0	0	1	1	0
88	0	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	1
91	0	0	0	0	0	0	0	0	0	0	1
92	0	0	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0	0
94	0	0	0	0	0	0	0	0	0	0	0
95	0	0	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0
100	1	0	0	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0	0	0	0
102	0	0	0	0	0	0	0	0	0	0	0
103	0	0	0	0	0	0	0	0	0	0	0
104	0	0	0	0	0	0	0	0	0	0	0
105	0	0	0	0	0	0	0	0	0	0	0
106	0	0	0	0	0	0	0	0	0	0	0
107	0	0	0	0	0	0	0	0	0	0	1
108	0	0	0	0	0	0	0	0	0	0	0
109	0	0	0	0	0	0	0	0	0	0	1
110	0	0	0	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	1	0	0	0	0
112	0	0	0	0	0	0	0	0	0	0	0
113	0	0	0	0	0	0	0	0	0	0	0
114	0	0	0	0	0	0	0	0	0	0	0
115	0	0	0	0	0	0	0	0	0	0	0
116	0	0	0	0	0	0	0	0	0	0	0

Study	Flexibility	Reconfigurability	Expressiveness	Readability	Modifiability	Adaptability	Portability	Modularity	Reusability	Maintainability	Evolvability
117	0	0	0	0	0	0	0	0	0	0	0
118	0	0	0	0	0	0	0	0	1	0	0
119	0	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0	0
121	0	0	0	0	0	0	0	0	0	0	0
122	0	0	0	0	0	0	0	0	0	0	0
123	0	0	0	0	0	0	0	0	0	0	0
124	0	0	0	0	0	0	0	1	0	0	0
125	0	0	0	0	0	0	0	0	0	0	0
126	0	0	0	0	0	0	0	0	0	0	0
127	0	0	0	0	0	0	0	0	0	0	0
128	0	0	0	0	0	0	0	0	0	0	0
129	0	0	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0	0
131	0	0	0	0	0	0	0	0	0	0	0
132	0	0	0	0	0	0	0	0	0	0	0
133	0	0	0	0	0	0	0	0	0	0	0
134	0	0	0	0	0	0	0	0	0	0	0
135	0	0	0	0	0	0	0	0	0	0	0
136	0	0	0	0	0	0	0	0	0	0	0
137	0	0	0	0	0	0	0	0	0	0	0
138	0	0	0	0	0	0	0	0	0	0	0
139	0	0	0	0	0	0	0	0	0	0	0
140	0	0	0	0	0	0	0	0	0	0	0
141	0	0	0	0	0	0	0	0	0	0	0
142	0	0	0	0	0	0	0	0	0	0	0
143	0	0	0	0	0	0	0	0	0	0	0
144	0	0	0	0	0	0	0	0	0	0	0
145	0	0	0	0	0	0	0	0	0	0	0
146	0	0	0	0	0	0	0	0	0	0	0

Study	Flexibility	Reconfigurability	Expressiveness	Readability	Modifiability	Adaptability	Portability	Modularity	Reusability	Maintainability	Evolvability
147	0	0	0	0	0	0	0	0	0	0	0
148	0	0	0	0	0	0	0	0	0	0	0
149	0	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	0	0	0	0	0	0	0	0
152	0	0	0	0	0	0	0	0	0	0	0
153	0	0	0	0	0	0	0	0	0	0	0
154	0	0	0	0	0	0	0	0	0	0	0
155	0	0	0	0	0	0	0	0	0	0	0
156	0	0	0	0	0	0	0	0	0	0	0
157	0	0	0	0	0	0	0	0	0	0	0
158	0	0	0	0	0	0	0	0	0	0	0
159	0	0	0	0	0	0	0	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0	0
161	0	0	0	0	0	0	0	0	0	0	0
162	0	0	0	0	0	0	0	0	0	0	0
163	0	0	0	0	0	0	0	0	0	0	0
164	0	0	0	0	0	0	0	0	0	0	0
165	0	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0
167	0	0	0	0	0	0	0	0	0	0	0
168	0	0	0	0	0	0	0	0	0	0	0
169	0	0	0	0	0	0	0	0	0	0	0
170	0	0	0	0	0	0	0	0	0	0	0
171	0	0	0	0	0	0	0	0	0	0	0
172	0	0	0	0	0	0	0	0	0	0	0
173	0	0	0	0	0	0	0	0	0	0	0
174	0	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	0	0	0	0	0
176	0	0	0	0	0	0	0	0	0	0	0

Study	Flexibility	Reconfigurability	Expressiveness	Readability	Modifiability	Adaptability	Portability	Modularity	Reusability	Maintainability	Evolvability
177	0	0	0	0	0	0	0	0	0	0	0
178	0	0	0	0	0	0	0	0	0	0	0
179	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0
181	0	0	0	0	0	0	0	0	0	0	0
182	0	0	0	0	0	0	0	0	0	0	0
183	0	0	0	0	0	0	0	0	0	0	0
184	0	0	0	0	0	0	0	0	0	0	0
185	0	0	0	0	0	0	0	0	0	0	0
186	0	0	0	0	0	0	0	0	0	0	0
187	0	0	0	0	0	0	0	0	0	0	0
188	0	0	0	0	0	0	0	0	0	0	0
189	0	0	0	0	0	0	0	0	0	0	0
190	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0
192	0	0	0	0	0	0	0	0	0	0	0
193	1	0	0	0	0	0	0	0	0	0	0
194	0	0	0	0	0	0	0	0	0	0	0
195	0	0	0	0	0	0	0	0	0	0	0
196	0	0	0	0	0	0	0	0	0	0	0

4.5 Quality scores

#	Question
Q1	Is there a rationale provided for why the study was undertaken?
Q2	Is there an adequate description of the context (industry, laboratory setting, products used, etc.) in which the research was carried out?
Q3	Is there a justification and description for the research design?
Q4	Is there a clear statement of findings, including data that supports findings?
Q5	Did the researcher(s) critically examine his / her (their) own role, potential bias, and influence during the study?
Q6	Are limitations and credibility of the study discussed explicitly?

(1 = yes", 0 = no, and 0.5 = to some extent)

Study	Q1	Q2	Q3	Q4	Q5	Q6	Total score
1	1.0	1.0	0.0	0.5	0.0	0.0	2.5
2	1.0	0.5	0.5	1.0	0.5	1.0	4.5
3	1.0	1.0	1.0	1.0	0.5	0.5	5.0
4	1.0	0.5	0.5	0.5	0.5	0.5	3.5
5	1.0	1.0	1.0	1.0	1.0	1.0	6.0
6	1.0	1.0	0.5	1.0	0.0	0.0	3.5
7	0.5	0.5	0.0	0.0	0.0	0.0	1.0
8	1.0	1.0	1.0	1.0	0.0	1.0	5.0
9	1.0	0.5	0.5	0.5	0.5	0.5	3.5
10	1.0	0.0	0.0	0.5	0.0	0.0	1.5
11	1.0	1.0	1.0	1.0	0.0	0.5	4.5
12	1.0	1.0	1.0	1.0	0.0	0.0	4.0
13	1.0	1.0	1.0	1.0	0.0	1.0	5.0
14	1.0	0.5	0.5	0.5	0.5	0.5	3.5
15	1.0	1.0	1.0	1.0	0.0	0.0	4.0
16	1.0	1.0	1.0	1.0	1.0	1.0	6.0
17	1.0	1.0	1.0	1.0	0.5	1.0	5.5
18	1.0	0.5	0.5	0.5	0.5	0.5	3.5
19	1.0	1.0	1.0	1.0	0.0	0.0	4.0
20	1.0	0.5	0.0	0.5	0.0	0.5	2.5
21	1.0	1.0	0.5	1.0	0.0	0.0	3.5
22	1.0	0.5	0.0	0.0	0.5	0.5	2.5
23	1.0	1.0	0.0	1.0	0.0	0.5	3.5
24	1.0	1.0	0.5	1.0	0.0	0.5	4.0
25	1.0	0.5	0.0	1.0	0.0	1.0	3.5
26	1.0	1.0	0.5	1.0	0.0	0.5	4.0
27	1.0	0.5	0.0	0.5	0.0	0.5	2.5
28	1.0	1.0	1.0	1.0	0.0	0.5	4.5
29	1.0	0.5	0.0	0.5	0.0	0.5	2.5
30	1.0	0.5	0.0	0.0	0.0	0.5	2.0

Study	Q1	Q2	Q3	Q4	Q5	Q6	Total score
31	1.0	0.5	0.0	0.5	0.0	0.5	2.5
32	1.0	0.5	0.5	0.0	0.0	0.5	2.5
33	1.0	0.5	0.0	1.0	0.5	0.5	3.5
34	1.0	0.5	0.0	0.5	0.0	0.5	2.5
35	1.0	0.0	0.0	0.5	0.0	0.5	2.0
36	1.0	0.5	0.0	0.5	0.0	0.5	2.5
37	1.0	1.0	1.0	1.0	0.5	0.5	5.0
38	1.0	1.0	1.0	1.0	0.5	0.5	5.0
39	1.0	0.0	0.0	0.5	0.0	1.0	2.5
40	1.0	1.0	1.0	1.0	0.0	1.0	5.0
41	1.0	1.0	1.0	0.5	0.0	0.5	4.0
42	1.0	1.0	1.0	1.0	1.0	1.0	6.0
43	1.0	1.0	0.0	1.0	0.0	0.0	3.0
44	1.0	1.0	0.5	0.0	0.0	0.0	2.5
45	1.0	1.0	0.5	0.5	0.0	0.5	3.5
46	1.0	1.0	1.0	1.0	1.0	1.0	6.0
47	1.0	1.0	1.0	1.0	0.5	0.5	5.0
48	1.0	0.5	0.5	0.5	0.0	0.5	3.0
49	1.0	1.0	1.0	0.5	0.0	0.5	4.0
50	1.0	1.0	0.0	0.5	0.0	0.0	2.5
51	1.0	1.0	1.0	1.0	0.0	1.0	5.0
52	1.0	1.0	1.0	1.0	0.5	1.0	5.5
53	1.0	1.0	1.0	1.0	0.0	0.5	4.5
54	1.0	1.0	1.0	1.0	0.0	0.5	4.5
55	1.0	1.0	0.5	0.5	0.5	0.5	4.0
56	1.0	1.0	1.0	1.0	0.0	0.5	4.5
57	1.0	1.0	1.0	1.0	1.0	1.0	6.0
58	1.0	1.0	1.0	1.0	0.5	0.5	5.0
59	1.0	1.0	1.0	1.0	0.5	1.0	5.5
60	1.0	1.0	0.0	0.5	0.0	0.5	3.0
61	1.0	1.0	1.0	1.0	0.5	0.5	5.0
62	1.0	1.0	0.5	0.5	0.0	0.5	3.5
63	1.0	0.5	0.5	1.0	0.5	0.5	4.0
64	0.5	1.0	0.0	0.0	0.0	0.0	1.5
65	1.0	1.0	0.0	1.0	0.0	0.5	3.5
66	1.0	1.0	1.0	1.0	0.5	1.0	5.5
67	1.0	1.0	1.0	0.5	0.0	0.5	4.0
68	1.0	0.5	0.5	0.5	0.0	0.5	3.0
69	0.0	1.0	0.0	0.0	0.0	0.0	1.0
70	1.0	1.0	0.5	0.5	0.0	0.0	3.0
71	1.0	1.0	0.5	0.5	0.0	0.0	3.0
72	1.0	0.5	0.5	0.5	0.0	0.5	3.0

Study	Q1	Q2	Q3	Q4	Q5	Q6	Total score
73	1.0	1.0	1.0	1.0	0.5	0.5	5.0
74	1.0	1.0	0.5	0.5	0.5	0.5	4.0
75	1.0	1.0	1.0	0.5	0.5	0.0	4.0
76	1.0	0.5	0.5	1.0	0.0	0.0	3.0
77	1.0	1.0	0.5	0.5	0.5	0.5	4.0
78	1.0	1.0	0.5	0.5	0.5	0.5	4.0
79	1.0	1.0	1.0	1.0	0.0	0.5	4.5
80	1.0	0.5	0.0	0.5	0.0	0.0	2.0
81	1.0	1.0	0.5	0.5	0.5	1.0	4.5
82	1.0	1.0	0.5	0.5	0.0	0.0	3.0
83	1.0	1.0	0.5	0.5	0.5	1.0	4.5
84	1.0	0.5	0.5	0.5	0.0	0.5	3.0
85	1.0	1.0	0.5	0.5	0.5	0.5	4.0
86	1.0	0.5	0.5	0.5	0.0	0.5	3.0
87	1.0	0.5	0.5	0.5	0.0	1.0	3.5
88	1.0	1.0	0.5	0.5	0.5	0.5	4.0
89	0.5	0.5	0.0	0.5	0.0	0.0	1.5
90	1.0	0.5	0.0	0.5	0.0	0.5	2.5
91	0.5	0.5	0.0	0.5	0.0	0.5	2.0
92	1.0	1.0	0.5	0.5	1.0	0.5	4.5
93	0.5	0.5	0.5	0.5	0.5	0.5	3.0
94	0.5	0.5	0.5	0.5	0.0	0.5	2.5
95	1.0	0.5	0.0	0.5	0.0	0.5	2.5
96	1.0	0.5	0.0	0.5	0.0	1.0	3.0
97	1.0	0.5	0.0	1.0	0.0	0.5	3.0
98	0.5	0.0	0.0	0.5	0.0	0.5	1.5
99	0.5	0.0	0.0	0.5	0.0	0.5	1.5
100	0.5	0.5	0.0	0.5	0.0	0.5	2.0
101	0.5	0.0	0.0	0.5	0.0	0.5	1.5
102	1.0	0.5	0.5	0.5	0.0	0.5	3.0
103	1.0	0.5	0.0	0.5	0.0	0.5	2.5
104	1.0	0.0	0.0	0.5	0.0	0.5	2.0
105	1.0	0.5	0.5	0.5	0.0	0.5	3.0
106	1.0	0.5	0.0	0.5	0.0	0.5	2.5
107	1.0	0.5	0.5	0.5	0.5	0.5	3.5
108	1.0	0.5	0.5	0.5	0.0	0.5	3.0
109	1.0	0.5	0.5	0.5	0.0	0.5	3.0
110	1.0	0.5	0.5	0.5	0.0	0.5	3.0
111	0.0	0.0	0.0	0.5	0.0	0.0	0.5
112	0.5	0.5	0.0	0.5	0.0	0.5	2.0
113	1.0	1.0	0.5	0.0	1.0	0.5	4.0
114	1.0	0.5	0.0	0.5	0.0	0.5	2.5

Study	Q1	Q2	Q3	Q4	Q5	Q6	Total score
115	0.5	0.5	0.0	0.5	0.0	0.5	2.0
116	1.0	1.0	0.5	0.5	0.5	0.5	4.0
117	0.5	0.5	0.0	0.5	0.0	0.5	2.0
118	1.0	1.0	1.0	0.5	0.5	0.5	4.5
119	0.5	0.5	0.0	0.5	0.0	0.5	2.0
120	1.0	0.5	0.5	0.5	0.0	0.5	3.0
121	1.0	0.0	0.0	0.5	0.0	0.5	2.0
122	0.5	0.5	0.0	0.5	0.0	0.5	2.0
123	0.5	0.5	0.5	0.5	0.5	0.5	3.0
124	1.0	0.5	0.5	0.5	0.5	0.5	3.5
125	1.0	0.0	0.0	0.5	0.0	0.5	2.0
126	0.5	0.5	0.0	0.5	0.0	0.5	2.0
127	1.0	0.0	0.0	0.5	0.0	0.5	2.0
128	0.5	0.5	0.0	0.5	0.0	0.5	2.0
129	1.0	0.5	0.0	0.5	0.0	0.5	2.5
130	0.5	0.0	0.0	0.5	0.0	0.5	1.5
131	0.5	0.0	0.0	0.5	0.0	0.5	1.5
132	1.0	0.5	0.0	0.5	0.0	0.5	2.5
133	0.5	0.0	0.0	0.5	0.0	0.5	1.5
134	1.0	0.5	0.0	0.5	0.0	0.5	2.5
135	0.5	0.0	0.0	0.5	0.0	0.5	1.5
136	0.5	0.0	0.0	0.0	0.0	0.5	1.0
137	0.5	0.5	0.5	0.5	0.5	0.5	3.0
138	0.5	0.0	0.0	0.5	0.0	0.0	1.0
139	0.5	0.0	0.0	0.5	0.0	0.5	1.5
140	0.5	0.5	0.0	0.5	0.0	0.5	2.0
141	1.0	1.0	1.0	1.0	0.5	0.5	5.0
142	1.0	0.5	0.5	0.5	0.5	1.0	4.0
143	0.5	0.5	0.5	0.5	0.5	0.5	3.0
144	1.0	1.0	1.0	1.0	0.5	1.0	5.5
145	0.5	0.0	0.0	0.5	0.0	0.5	1.5
146	1.0	1.0	1.0	1.0	0.5	1.0	5.5
147	0.5	0.0	0.0	0.5	0.0	0.5	1.5
148	1.0	0.0	0.0	0.5	0.0	0.5	2.0
149	1.0	0.5	1.0	0.5	0.5	0.5	4.0
150	1.0	0.5	1.0	1.0	0.5	1.0	5.0
151	1.0	0.5	0.5	0.5	0.5	0.5	3.5
152	0.5	0.5	0.5	0.5	0.0	0.5	2.5
153	0.5	0.0	0.5	0.5	0.0	0.5	2.0
154	0.5	0.0	0.0	0.5	0.0	0.5	1.5
155	1.0	0.5	0.5	0.5	0.5	0.5	3.5
156	1.0	0.5	0.5	0.5	0.0	0.5	3.0

Study	Q1	Q2	Q3	Q4	Q5	Q6	Total score
157	1.0	1.0	1.0	0.5	1.0	0.5	5.0
158	1.0	0.5	1.0	1.0	0.5	0.5	4.5
159	0.5	0.5	0.0	1.0	0.0	0.5	2.5
160	1.0	0.5	1.0	0.5	0.5	0.5	4.0
161	0.5	0.0	0.0	0.5	0.0	0.5	1.5
162	1.0	1.0	0.5	0.5	0.0	0.5	3.5
163	0.5	0.0	0.0	0.5	0.0	0.5	1.5
164	1.0	1.0	0.5	0.5	0.5	0.5	4.0
165	1.0	1.0	1.0	0.5	0.5	0.5	4.5
166	1.0	1.0	0.5	0.5	0.5	0.5	4.0
167	1.0	0.5	0.0	0.5	0.0	0.5	2.5
168	0.5	0.5	0.0	0.5	0.0	0.5	2.0
169	0.5	0.0	0.0	0.5	0.0	0.5	1.5
170	1.0	0.0	0.0	0.5	0.0	0.5	2.0
171	0.5	0.0	0.0	0.0	0.0	0.5	1.0
172	1.0	0.0	0.0	0.5	0.0	0.5	2.0
173	1.0	0.5	0.0	0.5	0.0	0.5	2.5
174	0.5	0.0	0.0	0.5	0.0	0.5	1.5
175	0.5	0.0	0.0	0.5	0.0	0.5	1.5
176	0.5	0.5	0.5	0.5	0.0	0.5	2.5
177	1.0	0.0	0.5	0.5	0.0	0.0	2.0
178	1.0	0.0	0.0	0.5	0.0	0.0	1.5
179	1.0	0.5	0.0	0.5	0.0	0.0	2.0
180	1.0	0.0	0.0	0.5	0.0	0.5	2.0
181	0.5	0.0	0.0	0.5	0.0	0.0	1.0
182	0.5	0.0	0.0	0.5	0.0	0.0	1.0
183	0.5	0.0	0.0	0.0	0.0	0.0	0.5
184	0.5	0.0	0.0	0.0	0.0	0.0	0.5
185	0.5	0.5	0.0	0.5	0.0	0.5	2.0
186	1.0	0.0	0.0	0.5	0.0	0.0	1.5
187	1.0	1.0	1.0	1.0	0.5	1.0	5.5
188	0.5	1.0	0.5	0.5	0.0	0.0	2.5
189	0.5	1.0	0.0	0.5	0.0	0.0	2.0
190	0.0	0.0	0.0	0.0	0.0	0.0	0.0
191	1.0	1.0	0.5	0.5	0.0	0.0	3.0
192	0.5	0.0	0.5	0.5	0.0	0.0	1.5
193	0.5	0.0	0.0	0.5	0.0	0.0	1.0
194	1.0	1.0	1.0	1.0	0.0	0.5	4.5
195	1.0	1.0	0.5	1.0	0.5	1.0	5.0
196	0.0	0.5	0.0	0.0	0.0	0.0	0.5

4.6 Citation counts

(based on Google Scholar, as of May 2013)

Study	Citation count
1	11
2	31
3	8
4	88
5	428
6	59
7	198
8	27
9	86
10	4
11	130
12	94
13	18
14	168
15	70
16	15
17	229
18	64
19	17
20	126
21	42
22	12
23	1
24	16
25	2
26	23
27	38
28	84
29	173
30	5
31	30
32	26
33	491
34	59
35	192
36	13
37	48
38	197

Study	Citation count
39	38
40	87
41	49
42	8
43	43
44	7
45	107
46	20
47	17
48	12
49	21
50	150
51	10
52	3
53	14
54	202
55	35
56	5
57	7
58	12
59	14
60	15
61	7
62	83
63	7
64	38
65	75
66	15
67	61
68	62
69	21
70	38
71	32
72	38
73	23
74	22
75	114
76	193
77	26
78	3
79	313
80	72

Study	Citation count
81	128
82	8
83	29
84	33
85	108
86	6
87	52
88	27
89	36
90	20
91	5
92	14
93	57
94	5
95	66
96	116
97	124
98	25
99	24
100	16
101	16
102	80
103	3
104	35
105	2
106	67
107	7
108	53
109	36
110	2
111	15
112	43
113	171
114	37
115	6
116	6
117	46
118	18
119	65
120	30
121	46
122	50

Study	Citation count
123	19
124	218
125	15
126	33
127	51
128	41
129	19
130	51
131	66
132	27
133	8
134	101
135	197
136	9
137	43
138	5
139	26
140	1
141	1
142	58
143	2
144	37
145	380
146	44
147	6
148	30
149	6
150	16
151	9
152	10
153	10
154	5
155	26
156	1
157	63
158	1
159	5
160	7
161	9
162	13
163	18
164	4

Study	Citation count
165	22
166	8
167	48
168	16
169	53
170	345
171	9
172	3
173	681
174	8
175	44
176	8
177	49
178	6
179	79
180	34
181	29
182	67
183	2
184	24
185	167
186	27
187	31
188	8
189	6
190	11
191	6
192	225
193	41
194	106
195	44
196	43

4.7 Evidence levels

(0 = no evidence; 1 = evidence from demonstration or toy examples; 2 = evidence from expert opinions or observations; 3 = evidence from academic studies (e.g., controlled lab experiments); 4 = evidence from industrial studies (e.g., causal case studies); 5 = evidence from industrial practice)

Study	Evidence level
1	1
2	1
3	4
4	1
5	1
6	4
7	1
8	2
9	1
10	0
11	1
12	1
13	1
14	3
15	3
16	2
17	4
18	3
19	4
20	2
21	1
22	0
23	0
24	1
25	1
26	1
27	1
28	2
29	3
30	3
31	1
32	3
33	3
34	1
35	1
36	3
37	3

Study	Evidence level
38	1
39	1
40	3
41	1
42	1
43	0
44	0
45	1
46	4
47	1
48	0
49	1
50	0
51	4
52	1
53	3
54	1
55	1
56	2
57	4
58	3
59	3
60	1
61	2
62	1
63	1
64	0
65	1
66	3
67	1
68	1
69	0
70	1
71	2
72	1
73	3
74	4
75	0
76	1
77	1
78	1
79	2

Study	Evidence level
80	1
81	1
82	2
83	1
84	1
85	1
86	3
87	4
88	1
89	1
90	1
91	1
92	4
93	1
94	1
95	0
96	1
97	4
98	1
99	0
100	0
101	1
102	2
103	2
104	1
105	3
106	1
107	1
108	1
109	1
110	0
111	1
112	1
113	4
114	1
115	1
116	4
117	4
118	4
119	0
120	1
121	1

Study	Evidence level
122	4
123	2
124	3
125	1
126	4
127	1
128	4
129	4
130	1
131	1
132	4
133	1
134	1
135	1
136	1
137	1
138	1
139	1
140	2
141	3
142	3
143	1
144	3
145	1
146	4
147	0
148	1
149	1
150	3
151	4
152	1
153	1
154	1
155	2
156	1
157	3
158	3
159	1
160	3
161	0
162	2
163	1

Study	Evidence level
164	3
165	4
166	4
167	1
168	2
169	1
170	1
171	0
172	1
173	1
174	1
175	1
176	1
177	2
178	1
179	2
180	1
181	1
182	2
183	1
184	0
185	2
186	1
187	1
188	1
189	1
190	1
191	1
192	1
193	1
194	1
195	4
196	1

4.8 Types of study

(yes = empirical paper, no = non-empirical paper)

Study	Empirical paper
1	no
2	yes
3	no
4	no
5	no
6	yes
7	no
8	yes
9	no
10	yes
11	yes
12	no
13	no
14	no
15	yes
16	no
17	yes
18	no
19	no
20	no
21	no
22	no
23	no
24	yes
25	no
26	no
27	no
28	yes
29	yes
30	no
31	no
32	no
33	yes
34	no
35	no
36	yes
37	no
38	no

Study	Empirical paper
39	no
40	yes
41	yes
42	no
43	no
44	no
45	no
46	yes
47	no
48	no
49	no
50	no
51	yes
52	no
53	yes
54	yes
55	no
56	yes
57	yes
58	no
59	no
60	no
61	yes
62	no
63	no
64	no
65	no
66	yes
67	no
68	no
69	no
70	no
71	no
72	no
73	no
74	yes
75	yes
76	yes
77	no
78	no
79	no
80	no

Study	Empirical paper
81	no
82	no
83	no
84	no
85	no
86	no
87	no
88	no
89	no
90	no
91	yes
92	yes
93	no
94	no
95	no
96	no
97	yes
98	no
99	no
100	no
101	no
102	no
103	no
104	no
105	yes
106	no
107	no
108	no
109	no
110	no
111	no
112	no
113	yes
114	yes
115	yes
116	yes
117	no
118	yes
119	no
120	yes
121	no
122	yes

Study	Empirical paper
123	no
124	no
125	no
126	no
127	no
128	no
129	yes
130	no
131	no
132	yes
133	no
134	no
135	no
136	no
137	no
138	yes
139	no
140	no
141	yes
142	yes
143	yes
144	yes
145	no
146	yes
147	no
148	no
149	no
150	yes
151	yes
152	yes
153	no
154	no
155	no
156	no
157	yes
158	no
159	yes
160	yes
161	no
162	yes
163	yes
164	yes

Study	Empirical paper
165	yes
166	yes
167	no
168	no
169	no
170	no
171	no
172	no
173	no
174	no
175	no
176	no
177	no
178	no
179	no
180	no
181	no
182	no
183	no
184	no
185	no
186	no
187	no
188	no
189	no
190	no
191	no
192	no
193	no
194	no
195	yes
196	no

4.9 Tool support

(yes = tool support provided, no = no tool support provided)

Study	Tool support
1	no
2	yes
3	no
4	yes
5	no
6	yes
7	no
8	n/a
9	no
10	yes
11	yes
12	yes
13	yes
14	yes
15	yes
16	n/a
17	no
18	yes
19	n/a
20	yes
21	yes
22	no
23	n/a
24	yes
25	no
26	no
27	no
28	yes
29	yes
30	yes
31	yes
32	yes
33	yes
34	yes
35	yes
36	yes
37	yes
38	yes

Study	Tool support
39	no
40	n/a
41	yes
42	yes
43	no
44	no
45	yes
46	yes
47	no
48	yes
49	yes
50	no
51	yes
52	yes
53	no
54	yes
55	yes
56	yes
57	no
58	yes
59	yes
60	no
61	no
62	no
63	no
64	n/a
65	yes
66	n/a
67	yes
68	no
69	no
70	yes
71	no
72	yes
73	yes
74	yes
75	n/a
76	no
77	yes
78	no
79	no
80	no

Study	Tool support
81	yes
82	no
83	yes
84	yes
85	yes
86	yes
87	yes
88	yes
89	yes
90	yes
91	n/a
92	n/a
93	yes
94	yes
95	no
96	no
97	n/a
98	yes
99	no
100	no
101	yes
102	n/a
103	yes
104	yes
105	yes
106	yes
107	yes
108	yes
109	n/a
110	no
111	n/a
112	n/a
113	n/a
114	yes
115	yes
116	yes
117	yes
118	yes
119	no
120	no
121	no
122	no

Study	Tool support
123	yes
124	n/a
125	yes
126	yes
127	yes
128	yes
129	no
130	yes
131	yes
132	n/a
133	no
134	yes
135	n/a
136	no
137	yes
138	no
139	no
140	yes
141	n/a
142	n/a
143	no
144	n/a
145	yes
146	yes
147	yes
148	no
149	no
150	yes
151	no
152	no
153	yes
154	no
155	yes
156	yes
157	n/a
158	no
159	no
160	no
161	yes
162	no
163	yes
164	n/a

Study	Tool support
165	yes
166	yes
167	no
168	yes
169	no
170	yes
171	no
172	yes
173	yes
174	yes
175	no
176	yes
177	yes
178	yes
179	yes
180	yes
181	no
182	yes
183	no
184	no
185	no
186	no
187	yes
188	no
189	no
190	no
191	no
192	yes
193	n/a
194	yes
195	yes
196	no

5. DATA EXTRACTED TO PILOT DIMENSIONS OF VARIABILITY

5.1 Type (requirements type, representation)

	Requirement type		Representation				
Study	**Functional**	**Quality**	**Feature model**	**Rules/Conditions**	**Variant labels/annotations**	**Profiles**	**Change scenarios**
2		1		1		1	
3		1		1	1		
5		1		1			
11	1			1			
13	1	1		1			
17	1	1					1
24	1			1	1		
28	1		1				
37	1		1	1			
38		1		1			
42	1			1			
47		1			1		
51	1		1				
54	1	1		1	1	1	
55	1	1		1		1	
56	1			1	1		
59	1	1		1			
73	1	1		1			
81	1	1			1	1	
92	1	1			1		1
118	1	1	1				
146	1	1		1			
TOTAL	17	15	4	15	7	4	2

5.2 Type (artifact, orthogonality)

	Artifact						Orthogonality	
Study	**Scenario**	**Business process**	**Architecture**	**Component**	**Code fragment**	**Variable**	**Integrated**	**Separated**
2				1				1
3			1	1	1		1	
5			1	1				1
11			1	1			1	
13			1	1	1			1
17	1		1	1				1
24	1						1	
28			1					1
37			1	1				1
38			1					1
42		1						1
47				1	1			1
51				1	1		1	
54			1	1		1	1	
55			1	1				1
56				1				1
59			1	1		1		1
73			1		1			1
81				1				1
92	1		1				1	
118	1						1	
146	1		1					1
TOTAL	5	1	14	14	5	2	7	15

(1 = addressed by study)

5.3 Mechanisms (trigger, realization technique)

	Trigger				Realization technique			
Study	**Stakeholder**	**Business process**	**System**	**Environment**	**Reorganization**	**Selection**	**Value assignment**	**Code generation**
2			1			1		
3			1	1	1	1		
5			1	1		1		
11	1		1			1		
13	1			1		1		
17	1				1			
24	1					1		
28	1					1		
37				1	1			
38				1	1			
42		1			1			
47			1			1		
51	1					1		1
54	1			1	1	1	1	
55				1	1	1		
56	1					1		
59	1			1		1		
73	1					1		1
81	1					1		
92	1					1		
118	1					1		
146	1					1	1	
TOTAL	14	1	5	8	7	18	2	2

(1 = addressed by study)

5.4 Mechanisms (time of binding, automation)

	Time of binding		Automation		
Study	**Software construction / evolution**	**Runtime**	**Manual**	**Semi-automatic**	**Automatic**
2		1			1
3		1		1	
5		1			1
11	1			1	
13	1		1		
17	1		1		
24	1			1	
28	1			1	
37		1			1
38		1			1
42		1		1	
47		1			1
51	1			1	
54		1			1
55		1			1
56	1	1		1	
59		1			1
73		1		1	
81		1			1
92	1		1		
118	1			1	
146	1			1	
TOTAL	10	13	3	10	9

(1 = addressed by study)

6. STUDIES RELATED TO SOA

Study	Related to SOA
1	no
2	yes
3	no
4	yes
5	yes
6	no
7	no
8	no
9	yes
10	no
11	no
12	no
13	no
14	yes
15	yes
16	no
17	no
18	no
19	no
20	no
21	no
22	no
23	no
24	no
25	no
26	no
27	no
28	no
29	yes
30	no
31	yes
32	no
33	no
34	yes
35	yes
36	no
37	yes
38	no
39	yes

Study	Related to SOA
40	no
41	no
42	no
43	no
44	no
45	yes
46	no
47	yes
48	no
49	yes
50	yes
51	no
52	no
53	no
54	no
55	yes
56	no
57	yes
58	yes
59	no
60	yes
61	no
62	yes
63	yes
64	yes
65	no
66	yes
67	yes
68	no
69	yes
70	yes
71	no
72	yes
73	no
74	yes
75	no
76	no
77	yes
78	yes
79	no
80	no
81	no

Study	Related to SOA
82	yes
83	no
84	no
85	no
86	yes
87	no
88	yes
89	no
90	no
91	no
92	no
93	no
94	no
95	yes
96	no
97	no
98	no
99	no
100	no
101	no
102	no
103	no
104	no
105	no
106	no
107	no
108	no
109	no
110	no
111	no
112	no
113	no
114	no
115	no
116	no
117	no
118	no
119	no
120	no
121	no
122	no
123	no

Study	Related to SOA
124	no
125	no
126	no
127	no
128	no
129	no
130	yes
131	no
132	no
133	no
134	no
135	no
136	yes
137	no
138	no
139	no
140	yes
141	no
142	no
143	no
144	no
145	no
146	no
147	no
148	no
149	no
150	no
151	no
152	yes
153	no
154	no
155	no
156	no
157	no
158	no
159	no
160	no
161	no
162	no
163	no
164	no
165	no

Study	Related to SOA
166	yes
167	yes
168	no
169	yes
170	no
171	no
172	yes
173	yes
174	no
175	no
176	yes
177	no
178	no
179	no
180	no
181	no
182	no
183	no
184	no
185	no
186	no
187	no
188	no
189	yes
190	no
191	no
192	no
193	no
194	no
195	no
196	no

7. SEARCH STRINGS FOR LIMITED TARGETED AUTOMATED SEARCH

Journals:

```
TITLE-ABS-KEY ("variability" OR "variation point" OR "variant" OR "feature model"
OR "feature diagram" OR "product family" OR "product line") AND ( LIMIT-
TO(EXACTSRCTITLE,"Automated Software Engineering" ) OR LIMIT-
TO(EXACTSRCTITLE,"Empirical Software Engineering" ) OR LIMIT-TO(EXACTSRCTITLE,"IEEE
Software" ) OR LIMIT-TO(EXACTSRCTITLE,"Information and Software Technology" ) OR
LIMIT-TO(EXACTSRCTITLE,"Journal of Systems and Software" ) OR LIMIT-
TO(EXACTSRCTITLE,"Requirements Engineering" ) OR LIMIT-TO(EXACTSRCTITLE,"Science of
Computer Programming" ) OR LIMIT-TO(EXACTSRCTITLE,"Journal of Software Maintenance
and Evolution" ) OR LIMIT-TO(EXACTSRCTITLE,"Software and Systems Modeling" ) OR
LIMIT-TO(EXACTSRCTITLE,"Software Practice and Experience" ) OR LIMIT-
TO(EXACTSRCTITLE,"Software Testing Verification and Reliability" ) OR LIMIT-
TO(EXACTSRCTITLE,"ACM Transactions on Software Engineering and Methodology" ) OR
LIMIT-TO(EXACTSRCTITLE,"IEEE Transactions on Software Engineering" ) ) AND ( LIMIT-
TO(PUBYEAR,2011) OR LIMIT-TO(PUBYEAR,2010) OR LIMIT-TO(PUBYEAR,2009) OR LIMIT-
TO(PUBYEAR,2008) OR LIMIT-TO(PUBYEAR,2007) OR LIMIT-TO(PUBYEAR,2006) OR LIMIT-
TO(PUBYEAR,2005) OR LIMIT-TO(PUBYEAR,2004) OR LIMIT-TO(PUBYEAR,2003) OR LIMIT-
TO(PUBYEAR,2002) OR LIMIT-TO(PUBYEAR,2001) OR LIMIT-TO(PUBYEAR,2000) )
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Conferences:

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TITLE-ABS-KEY ("variability" OR "variation point" OR "variant" OR "feature model"
OR "feature diagram" OR "product family" OR "product line") AND ( LIMIT-
TO(EXACTSRCTITLE,"Automated Software Engineering Conference" ) OR LIMIT-
TO(EXACTSRCTITLE,"Advanced Information Systems Engineering" ) OR LIMIT-
TO(EXACTSRCTITLE,"Evaluation and Assessment in Software Engineering" ) OR LIMIT-
TO(EXACTSRCTITLE,"European Conference on Object-oriented programming" ) OR LIMIT-
TO(EXACTSRCTITLE,"European Conference on Software Architecture" ) OR LIMIT-
TO(EXACTSRCTITLE,"Proceedings of the ACM SIGSOFT Symposium on the Foundations of
Software Engineering" ) OR LIMIT-TO(EXACTSRCTITLE,"GPCE" ) OR LIMIT-
TO(EXACTSRCTITLE,"Proceedings - International Conference on Software Engineering" )
OR LIMIT-TO(EXACTSRCTITLE,"Conference on Software Maintenance" ) OR LIMIT-
TO(EXACTSRCTITLE,"Conference on Software Testing, Verification and Validation" ) OR
LIMIT-TO(EXACTSRCTITLE,"Symposium on Software Testing and Analysis" ) OR LIMIT-
TO(EXACTSRCTITLE,"Model Driven Engineering Languages and Systems" ) OR LIMIT-
TO(EXACTSRCTITLE,"Proceedings of the Conference on Object-Oriented Programming Sys-
tems, Languages, and Applications, OOPSLA" ) OR LIMIT-TO(EXACTSRCTITLE,"Quality of
Software Architecture" ) OR LIMIT-TO(EXACTSRCTITLE,"Requirements Engineering Con-
ference" ) OR LIMIT-TO(EXACTSRCTITLE,"Software Language Engineering" ) OR LIMIT-
TO(EXACTSRCTITLE,"Product Line Conference" ) OR LIMIT-TO(EXACTSRCTITLE,"Working
Conference on Software Architecture" ) ) AND ( LIMIT-TO(PUBYEAR,2011) OR LIMIT-
TO(PUBYEAR,2010) OR LIMIT-TO(PUBYEAR,2009) OR LIMIT-TO(PUBYEAR,2008) OR LIMIT-
TO(PUBYEAR,2007) OR LIMIT-TO(PUBYEAR,2006) OR LIMIT-TO(PUBYEAR,2005) OR LIMIT-
TO(PUBYEAR,2004) OR LIMIT-TO(PUBYEAR,2003) OR LIMIT-TO(PUBYEAR,2002) OR LIMIT-
TO(PUBYEAR,2001) OR LIMIT-TO(PUBYEAR,2000)
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